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(54) IMPROVEMENTS IN OR RELATING TO THE TREATMENT OF SEWAGE SYSTEMS

(71) I, CHARLES EDWARD TRAVERSE, a citizen of the United States of America, of Lake Waynewood, Wayne County, Pennsylvania, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is in the field of sewage treatment and is particularly directed to the aerobic treatment of sewage involving optimum aeration efficiency and adaptable for converting an anaerobic sewage treatment unit to operate on the preferable process.

Septic systems employing the anaerobic process are widely used in areas not having public sewage disposal facilities. Generally, such systems consist of a sewage collection tank, usually referred to as a septic tank, in conjunction with a cesspit into which effluent from the tank is discharged. Raw sewage normally flows by gravity into the septic tank where the solids gravitate to the bottom of the tank with liquid being discharged into the cess-pit to, hopefully, percolate downwardly into the surrounding soil.

The raw sewage rece'ved in septic tanks usually contain organic constituents including protein, carbohydrates and fats, oxygen activated organisms which function biochemically to decompose the organic constituents, and a limited natural supply of oxygen which activates the organisms to decompose the organic constituents. Initially in the biolysis of sewage deposited in the septic tank, urea, ammonia, and other products of the digestive putrefactive decomposition are partially oxidized so as to consume the limited amount of oxygen initially present in the raw sewage. Consequently, further decomposition of the sewage is by the anaerobic process. Continued putrefaction occurs under the anaerobic conditions so that the proteins are broken down to form urea, ammonia, foul-smelling mercaptans such as hydrogen sulfide and fatty and aromatic acids. Carbohydrates are broken down into their original fatty acid, water, carbon dioxide, hydrogen, methane and other substances. Fats and soaps are affected similarly to the hydrocarbons and are broken down to form the original acids of their constituency as well as carbon dioxide, hydrogen, methane. Stable nitrites and nitrates are produced as the final product of the anaerobic decomposition process.

One substantial disadvantage of anaerobic sewage treatment in septic tanks is that there is an eventual accumulation of solid materials in the tank which must be periodically removed in order to avoid clogging of the cess-pit and consequent discharge of raw sewage in the area of the tank. Additionally, the efficiency of a septic tank is largely dependent upon the soil conditions in which the cess-pit is located since the percolation of the soil is determinative of the size of the cess-pit and its consequent capacity for receiving and disposing of liquid efflent. In some areas, it is impossible to employ septic tanks due to the poor percolation characteristics of the soil.

The deficiencies of anaerobic process septic tanks have resulted in a substantial movement toward the usage of aerobic sewage treatment systems which also employ a receiving tank and a drain field but which additionally employ means for supplying oxygen to the sewage during its entire treatment process to provide a more complete decomposition than is normally obtainable in an anaerobic system. While the aerobic sewage treatment units that are commercially available have provided substantial advantages over the older anaerobic systems, they have suffered from a number of deficiencies from the standpoint of cost of manufacture, operation and maintenance

which have slowed their acceptance as a substitute for the older anaerobic systems.

One of the more common problems with prior known commercial aerobic sewage treatment systems is that they fail to adequately dissipate the solid materials in the sewage and such materials consequently are discharged from the tank without full treatment. The discharge of solid materials into the cess-pit is highly undesirable since it can result in a blockage of the cess-pit within a relatively short time. In an effort to preclude the discharge of solid materials, some units have employed filters upstream of the outlet of the cess-pit. However, this approach has not proven to be satisfactory since the filters soon become clogged and must be replaced in order to remain effective.

Various other expedients have been employed in the prior known aerobic sewage treatment units such as aerators in the bottom of the main receiving tank, mechanical agitation devices, and macerators. Frequently, devices of the foregoing type have been overly complex and consequently prone to high expenses of initial manufacture as well as of maintenance. Other problems with prior known systems include failure to obtain optimum oxygenation in a rapid manner which necessitates the employment of a larger main tank than would be necessary if increased rates of oxygenation could be effected.

One example of a system proposed for incorporation into a septic tank system is disclosed in U.S. Patent 3,662,890. Patentee proposes to withdraw liquid from the septic tank, treat it with air under pressure, and return the treated liquid to the septic tank. The patented system is completely hydraulic and relies on radial sparging of the air into the liquid. Pressure is maintained in the treatment vessel at all times by a gate valve in the discharge conduit.

In order to avoid the above-described problems and to improve sewage treatment, one aspect of the invention provides sewage apparatus for collecting and treating a contaminated liquid, for example domestic sewage, which comprises an elongate, generally cylindrical treatment vessel having a tangential inlet at one end and a tangential outlet at the other end, whereby contaminated liquid, withdrawn from a single chamber cess-pit and introduced into the treatment vessel, is subjected to turbulence as such liquid is caused to circulate around the circumference of the vessel and along its axis, means in the treatment vessel for contacting and reducing the size of floc particles in the liquid, an inlet for introducing an oxygen-containing gas into the liquid in the vessel, whereby floc particles in the liquid are subjected to size reduction and oxygen transfer to cause aerobic treatment of the contaminated liquid and means for directing a portion of the treated liquid, in use, to an outlet baffle of the cess-pit.

Another aspect of the invention provides a method of treating contaminated liquid, for example domestic sewage, which comprises withdrawing a portion of the contaminated liquid from a cess-pit and injecting it into a closed treatment vessel, causing the liquid to flow tangentially through the vessel under conditions of hydraulic turbulence, so that floc particles in the liquid are subjected to shear forces by moving across contacting and reducing members disposed in the vessel, and injecting an oxygen-containing gas into the vessel, whereby the portion of the contaminated liquid is aerobically treated by micro-liquefaction of the floc particles in the contaminated liquid.

Preferably the apparatus comprises further means for returning treated liquid to the cess-pit and, also, a knife edge may be disposed longitudinally in the treatment vessel, so as to contact floc particles. The gas inlet is preferably disposed adjacent the tangential inlet of the treatment vessel and may also be associated with an air compressor from whose discharge a conduit extends to the treatment vessel. Furthermore, the gas inlet may be disposed beneath a baffle, preferably comprising an angle member having an inverted V-shaped cross-section and having sharpened outer edges, which baffle extends substantially the length of the vessel, so that the oxygen-containing gas can be conducted along the length of the baffle. A centrifugal pump may be used to withdraw liquid from the cess-pit and the impeller of the pump preferably has sharpened leading and trailing edges to reduce the floc particles by mechanical shear forces. In addition, a portion of the treated fluid may be directed to an outlet baffle of the cess-pit via a conduit connected between the tangential outlet of the treatment vessel and the outlet baffle.

A preferred embodiment, in accordance with the inventive apparatus will now be described by way of example and with reference to the accompanying drawings in which:

Figure 1 is a partial perspective view of the preferred embodiment of apparatus mounted in a conventional cess-pit with portions removed for reasons of clarity.

Figure 2 is a sectional view taken along lines 2—2 of Figure 1;

Figure 3 is a sectional view taken along lines 3—3 of Figure 2;

Figure 4 is a top plan view of the apparatus shown in Figures 1 to 3; and

Figure 5 is a sectional view taken along lines 5—5 of Figure 4.

The present invention is designed to utilize any cess-pit, without modifications, such as special compartments, as a biological reactor. This in itself is a radical departure from conventional sewage plants. A conventional, extended aeration plant employs compartmented tanks, that is, raw sewage drains into the first compartment where it is aerated, the mixed liquor flows from this compartment into a second settling compartment where the activated sludge solids settle to the bottom of the compartment and the clear liquor on the surface is discharged from the tank. The activated sludge solids that have accumulated on the bottom of the settling compartment are then pumped or otherwise directed back into the aeration compartment for further treatment usually at timed intervals.

The inventive method and apparatus of the present invention produces a flotation that is so complete that there are no activated sludge solids on the bottom of the tank, that is, the cess-pit, and the digestion is accelerated to such an extent that only a single compartment tank, or cess-pit, is necessary.

The following definitions will explain the primary terms used in the specification and claims of the instant application.

Floc Particle and Eddy Film: Examine sewage under a microscope and you will find it is composed of micro-organisms (bacteria). Each individual micro-organism or bacterium is called a floc particles which in turn is covered by a thin film of moisture called an eddy film.

Micro-Liquefaction: The process of reducing the floc particle diameters and eddy film thickness of the micro-organisms present in the sewage into progressively smaller floc particle diameters and thinner eddy film thickness on a continual basis.

Aerobic Treatment: When micro-liquefaction is effected in the presence of air, or some other oxygen-bearing medium, optimum molecular transfer of oxygen and nutrients into solution is produced at the super-saturation level.

The prior art processes of aerobic sewage treatment utilize at least a two compartment tank, the first or aeration compartment being supplied with ample nutrient (raw sewage) so that bacteria begin to grow to ten times their average size in every dimension. The bacteria or flock particles multiply by self-dividing so one bacterium can multiply up to five trillion times in one day. With ample nutrient supply, bacteria (floc) bodies become light and fluffy so they do not settle in the water (sewage liquor). The oxygen environment in the first compartment promotes the growth of aerobes known as protozoa (amoeba, free swimming ciliata, and stalked ciliata) and rotifera which eat and digest the bacteria (floc). The fluffy bacteria particles flow over a weir into a second or settling compartment where no raw sewage enters so the bacteria are starved of nutrients, thus they cease to multiply and begin to contract by consuming a portion of their own bodies. Thus, the starved bacteria become heavier and settle to the bottom of the compartment where they are directed back into the aeration compartment for further digestion by the aerobes. A more detailed discussion of aerobic sewage treatment can be found in Volume I of *Treatment and Disposal of Wastewater from Homes by Soil Infiltration and Evapotranspiration*, by Dr. Alfred P. Bernhard, University of Toronto Press, 1973.

If aeration is attempted in a single compartment such as in conventional septic tanks, the light and fluffy bacteria (floc) continue to multiply, thus covering the surface of the liquid. This condition is called sludge bulking, which may eventually block theh cess-pit because the rate of digestion of floc would be far less than the growth rate of the floc.

The unique micro-liquefaction process of the present invention makes it possible to physically reduce the bacteria (floc) into smaller and smaller particle sizes so they are readily digested by the aerobes (protoza and rotifera). The process of the present invention causes rapid digestion of the bacteria (floc) so that they are constantly in a starved condition, thus settling to the bottom of the same compartment where they are aerated, thus eliminating the second or settling tank necessary for a conventional extended aeration process or plant. According to the present invention, the bacteria settling to the bottom of the single compartment biological reactor are continuously subjected to successive micro-liquefaction processes. A six-month testing program under laboratory conditions of the process of the present invention showed that micro-liquefaction can provide a virtually 100% sludge-free sewage treatment process.

The prior art does not disclose a method for micro-liquefaction of the floc particle and eddy film thickness of the micro-organisms present in the sewage. Examples of the prior art such as comminutors, macerators, mechanical agitating devices, aerators in the bottom of the main receiving tank, or in the case of U.S. Patent 3,662,890, axial jets of air from a perforated internal sparger enclosed in a small auxiliary aeration chamber do not effectively result in the micro-liquefaction of the micro-organisms present in the sewage. The prior art methods and apparatus effect, for comparison purposes, reduction of the solids to golf ball-size particles, as compared to the present inven-

tion which reduces such solids to the size approximately the head of a pin. The prior processes also do not benefit from the optimum oxygen transfer effect by micro-liquefaction. The present invention involves a unique method of micro-liquefaction employing mechanical forces combined with liquid tangential movement across knife edges and hydraulic turbulence to create great shear forces across the knife edges to produce efficient and complete micro-liquefaction. This is accomplished by employing liquid tangential flow across knife edges together with hydraulic turbulence in a unique treating vessel (micro-liquefaction chamber) which produces great shear forces across the knife edges. The turbulence is produced by forcibly injecting 30 GMP of liquid and 1.1 CFM of air or other oxygen-bearing medium into a chamber with a volumetric capacity of only .66 gallons.

In Figure 1 of the drawings, the preferred embodiment of the apparatus, generally designated 8, is shown mounted on a conventional, single chamber cess-pit 10 which would normally be buried in the ground in an area as conveniently close to the facilities to be served by the unit as practical. The cess-pit 10 comprises a bottom wall 12, a top wall 13, an end wall 15, through which an inlet pipe 16 extends with its end in the form of a sanitary tee member, and an opposite end wall 17 with an outlet 18. The cess-pit 10 also includes a front wall (not shown) and a rear wall 19. The interior of the cess-pit 10 defines a sewage digestion chamber 20 with the solids gravitating downwardly to the bottom of the chamber, as illustrated in Figure 1. When the level of the liquid in the chamber 20 reaches the same height as the outlet 18, liquid effluent will be discharged to a drainage field to eventually percolate downwardly into the ground. A vent pipe 22 is provided through the top wall 13 of the cess-pit tank 10 for permitting the escape of gases fro the chamber 20.

The preferred embodiment of apparatus in accordance with the invention is positioned over an opening 24 in the top wall 13 of the cess-pit 10 and includes a base plate 26 resting on the upper surface of the top wall 13 and completely overlying and covering the opening 24.

A treatment vessel (micro-liquefaction chamber) 28, consisting of a horizontal, generally cylindrical portion 30 having its ends closed by end plates 32 and 34, is mounted on the base plate 26, the plates 32 and 34, which rest on the base plate 26, being normally welded or otherwise secured thereto. A tangential inlet conduit 36 is connected to the cylindrical portion 30 of vessel 28 adjacent the end wall 32, as illustrated in Figures 1 and 5. Additionally, a tangential outlet conduit 38 is connected to the opposite end of the cylindrical portion 30 of vessel 28 adjacent the end plate 34. The inlet and outlet conduits 36 and 38 are oriented to provide a vortex flow therebetween as illustrated by the arrows in Figure 1 for the purpose of achieving optimum micro-liquefaction and the resulting molecular transfer of oxygen and nutrients of the materials passing through the cylindrical portion 30 of vessel 28, as will hereinafter be explained. A source of compressed air 40 from compressor 41 is connected to an inlet fitting 42 in the end plate 32 positioned coaxially with respect to the cylindrical portion 30 of vessel 28 beneath a baffle 44 extending the length of the cylindrical portion 30. Baffle 44 comprises an inverted angle member having sharp edges 46, as shown in Figure 5, with the inlet fitting 42 being positioned with respect to the baffle, as illustrated in Figure 4. The swirling vortex of material in the interior of the cylindrical portion 30 causes the solids (floc) to engage the sharp edges 46 to provide intensifified micro-liquefaction of the nutrients and, as the articles are reduced in size, molecular transfer of the oxygen injected via the fitting 42, with the pressure in the tank being at approximately 3.5 pounds per square inch, is enhanced. The proximity between the sharp edges 46 of the baffle 44 and the inside wall of cylindrical portion 30 is such that large objects are thrown back into contact with the sharp edges 46 of the baffle many times before exiting from the vessel 28 through outlet conduit 38.

It should be clearly understood that the contaminated liquid flows tangentially under conditions of hydraulic turbulence causing very large shear forces to act on the floc particles reducing them in size and, thus, accomplishing the process called micro-liquefaction. The vessel 28 need not be under pressure, since the discharge conduit 38 is in no way valved or restricted.

A vertically-oriented pump support sleeve 48 extends downwardly from the base plate 26 to provide support for a unique micro-liquefaction centrifugal pump 50 including a housing 52 from which an axial inlet conduit 54 extends downwardly to a lower end termination 56, as illustrated in Figure 1. Pump support sleeve 48 encloses a hollow tubular axial pump drive shaft 58 supported in roller bearings and having its upper end drivingly connected to an electric motor 60 which also drives the air compressor 41.

A pump impeller 62 is fixedly connected to the lower end of the hollow drive shaft 58 and includes a top plate 63 and an S-shaped downwardly extending hollow impeller blade 64, as illustrated in Figure 3. An internal passageway 65 in the S-shaped impeller blade 64 is in communication with 1

the lower end of the hollow tubular drive shaft 58 and the outer end of the passageway 65 and is defined by a sharp edge 66, as illustrated also in Figure 3. An air inlet opening 67 is provided in the support sleeve 48 and a second opening 67[1] is provided in the upper end of the hollow tubular drive shaft 58.

The impeller 62 is driven by the motor 60 in the direction of the large arrow in Figure 3, so that the rotation of the impeller draws air downwardly through the openings 67 and 67[1] into the passageway 65 from which the air exits past the sharp edges 66. The movement of the impeller and the inflow of air provide an extreme amount of hydraulic turbulence and micro-liquefaction of the nutrients and molecular transfer of the oxygen ingested into the pump housing with the input flow being directed upwardly through the inlet conduit 54 and then discharging outwardly through the outlet of the pump housing to an inlet line 72. It will be evident that the trailing edges 66 provide a primary micro-liquefaction of the solid particles flowing through the pump and the inflow of air through the impeller provides for optimum molecular transfer of the oxygen into solution with the liquid. The pump is designed to pass 30 GPM and ingest 2.9 CFM of air at the same time which is evidenced by an extreme pulsating discharge totally unique for a centrifugal-type pump.

The upper end of the outlet line 72 is connected to the tangential inlet conduit 36 of the vessel 28 and an oxygenated discharge conduit 74 is connected to the outlet conduit 38 for discharging aerobically-treated micro-liquefied sewage back into the cess-pit 10. The lower end of conduit 74 terminates above the level of the liquid in the cess-pit 10.

In the operation of the apparatus, the electric motor 60 is actuated to drive the pump 50 and the compressor 41. Operation of the pump 50 serves to pump primary liquefied sewage, dissolved and undissolved gases upwardly through the treatment vessel 28 (micro-liquefaction chamber), with air being injected into the vessel by means 40, 42, in a manner as discussed previously. The material passing through the cylindrical portion 30 of the vessel 28 is given a whirling vortex motion due to the orientation of the tangential inlet conduit 36 and the tangential outlet conduit 38. It is of particular importance that the tangential outlet conduit 38 is oriented so as to enhance the vortex flow through the cylindrical portion 30 of the vessel 28 to the fullest extent possible. The vortex of the material on the interior of vessel 28 moves rapidly past the sharp edges 46 of the baffle 44 to provide optimum reduction of the particle size of the floc, thus achieving liquefaction of the floc particles.

As the floc particles are reduced in size in the presence of an oxygen-containing gas present at the baffle surfaces, optimum oxygen transfer to the floc takes place.

Figure 5 illustrates an optional feature comprising an air injection line 70 for providing additional compressed air to the inlet conduit 54.

The flow of the liquid and solid materials across the sharp edges results in great shear forces and turbulence in the materials which mechanically and continually reduce the eddy film thickness and floc particle diameter of the micro-organisms present in the sewage. The production of increasingly thinner eddy film thickness and smaller particle diameters increases the transfer rate of oxygen and nutrients into the solution providing an optimum maximum dissolving of oxygen and nutrients into the sewage. The sewage, dissolved oxygen and non-dissolved gases, primarily consisting of nitrogen, are then discharged from the micro-liquefaction chamber by the conduit 74. The oxygenated sewage is consequently returned to the cess-pit 10 in which the dissolved gas and nutrients are mixed with sewage in the digestion chamber 20 to undergo aerobic treatment. Undissolved gases are vented by the vent pipe 22 into the atmosphere. Continuous inflow of raw sewage into the cess-pit 10 results in an eventual outflow of treated sewage from the outlet 18 in an obvious manner.

It was observed during the six-month test program that the suspended solids content of the biological reactor were consistently lower than that of the effluent discharging from a conventional septic system.

The lack of circulation of the liquid effluent in discharge baffle 18 of cess-pits 10 permits bacteria in the baffle 18 to grow light and fluffy and float on the surface of the liquid. Due to this sludge bulking, it becomes necessary to divert a small quantity of the discharge of the micro-liquefaction chamber 28 to the discharge outlet 18, thus maintaining a bacteria starved condition in the outlet so that the floc settles to the bottom of cess-pit 10. In order to accomplish this, an auxiliary conduit (or wash-out line) 100 is fitted between the outlet conduit 38 of the vessel 28 and the discharge outlet (sanitary tee) 18. This conduit 100 diverts a portion of the micro-liquefied sewage having a high dissolved oxygen (D.O.) content low $B.O.D._5$ and suspended solids content to the outlet 18, so that the floc contained therein is caused to fall to the bottom of the cess-pit 10 by the same starvation process that causes settling of the floc in the main portion of cess-pit 10.

Comparison tests were made of the efflu-

ent in the outlet 18, with and without micro-liquefied sewage flowing through the conduit 100. With micro-liquefied sewage flowing through the conduit 100, the tests showed no sludge bulking and a fifty (50%) percent decrease in suspended solids in the liquid in the outlet.

Another feature of the invention is realized by the provision of automatic venting means from the micro-liquefaction chamber induced by directing the discharge conduit 74 from the vessel 28 downwardly so it terminates in the air space above the liquid level in the cess-pit 10. The liquid, dissolved gases, and undissolved gases all pass through the conduit 74. The liquid and dissolved gases drop into the cess-pit 10 for aerobic process, while the undissolved gases, mostly nitrogen, pass to the atmosphere through the tank venting pipe 22. Thus, the treatment vessel or micro-liquefaction chamber 28 is self-venting.

Maximum biolysis of the sewage occurs by virtue of several construction features employed in the embodiment of the invention. Specifically, the pre-mixing of the sewage with air in the micro-liquefaction pump 50 serves to enhance the cutting operation of the impeller on solid particles as well as to oxygenate the sewage. The whirling vortex of material in the cylindrical portion 30, past the sharp edges 46 of the baffle 44, provides additional particle size reduction and oxygenation. Moreover, it has been found that the effluent discharged from the outlet 18 contains sufficient oxygen to continue the oxygenation process in the draining field exterior of the cess-pit 10.

In the biolysis of sewage in septic systems as previously discussed, the digestive process is conducted only for a short period of time under aerobic conditions until the supply of natural oxygen is consumed. After the natural oxygen has been consumed, the treatment process becomes an anaerobic process which eventually results in a low biochemical oxygen demand reduction (B.O.D.) in the order of 30 percent. The superiority of the present invention over such prior known systems is evidenced by the fact that the biological oxygen demand of the effluent from the present invention is of the order of 95 percent and the effluent is both odourless and clear.

It is contemplated that the present invention can be manufactured and employed as a new installation or that it can be installed on an existing cess-pit for the purpose of converting to an aerobic sewage treatment process. The apparatus provides substantial advantages due to the high quality of the effluent and does not require as substantial a draining field as is necessary with other types of system.

It is understood that the present invention is susceptible to numerous modifications and adaptations that will be obvious to those of skill in the art.

WHAT I CLAIM IS:—

1. Sewage apparatus for collecting and treating a contaminated liquid, for example domestic sewage, which comprises an elongate, generally cylindrical treatment vessel having a tangential inlet at one end and a tangential outlet at the other end, whereby contaminated liquid, withdrawn from a single chamber cess-pit and introduced into the treatment vessel, is subjected to turbulence as such liquid is caused to circulate around the circumference of the vessel and along its axis, means in the treatment vessel for contacting and reducing the size of floc particles in the liquid, an inlet for introducing an oxygen-containing gas into the liquid in the vessel, whereby floc particles in the liquid are subjected to size reduction and oxygen transfer to cause aerobic treatment of the contaminated liquid and means for directing a portion of the treated liquid, in use, to an outlet baffle of the cess-pit.

2. Apparatus according to claim 1 comprising means for returning treated liquid to the cess-pit.

3. Apparatus according to claim 1 or 2, wherein a knife edge is disposed longitudinally in the treatment vessel, so as to contact floc particles.

4. Apparatus according to any preceding claim, wherein the gas inlet is disposed adjacent the tangential inlet of the treatment vessel.

5. Apparatus according to any preceding claim, wherein the gas inlet is associated with an air compressor, a conduit extending between the discharge of the compressor and the vessel.

6. Apparatus according to any preceding claim, wherein the gas inlet is disposed beneath a baffle which extends substantially the length of the treatment vessel, so that the oxygen-containing gas is conducted along the length of the baffle.

7. Apparatus according to claim 6, wherein the baffle comprises an angle member having an inverted V-shaped cross-section, the outer edges of the angle member being sharpened.

8. Apparatus according to any preceding claim, wherein a centrifugal pump, including a housing having an impeller therein, are provided for withdrawing the liquid from the cess-pit.

9. Apparatus according to claim 8, wherein the impeller has sharpened leading and trailing edges, so as to reduce floc particles on contact by mechanical shear forces.

10. Apparatus according to any preced-

ing claim wherein said means for directing a portion of the treated liquid, in use, to an outlet baffle of the cess-pit comprises a conduit connected between the tangential outlet of the vessel and the outlet baffle.

11. Sewage treatment apparatus according to claim 1, substantially as hereinbefore described with reference to the accompanying drawings.

12. An aerobic sewage treatment apparatus comprising an overflowing, single chamber cess-pit having a raw sewage inlet and an effluent discharge outlet, a closed, cylindrical treatment vessel, for treating the sewage by micro-liquefaction of floc particles contained therein, having a tangential sewage inlet at one end and a tangential outlet at the other end, a baffle disposed axially within the treatment vessel and having at least one edge for contacting and reducing the size of floc particles by mechanical shear forces, an inlet for introducing an oxygen-containing gas into the treatment vessel below the baffle so that the baffle serves to distribute the gas throughout the vessel, a centrifugal pump disposed in the cess-pit and arranged to conduct sewage therefrom to a conduit connected to the treatment vessel inlet, for introducing sewage into the vessel, the pump including a housing containing an impeller having blades with sharp edge portions, for contacting and reducing the size of floc particles before entering the vessel, whereby the pump induces hydraulic turbulence in the liquid as it passes through the vessel, so that floc particles therein are further reduced in size by contact with the baffle as the oxygen containing gas is introduced into the liquid to cause aerobic treatment of the liquid, and means for conducting a portion of the treated liquid, in use, from the outlet of the treatment vessel to the discharge outlet of the cess-pit.

13. An apparatus according to claim 12 comprising means for discharging effluent from the treatment vessel into the cess-pit above the level of liquid contained therein.

14. An apparatus according to claim 12 or 13, wherein the baffle comprises an angle member having an inverted V-shaped cross section with sharp, outer edge portions.

15. An apparatus according to any of claims 12 to 14, wherein said means for conducting a portion of the treated liquid from the outlet of the treatment vessel to the discharge outlet of the cses-pit comprises a conduit connected therebetween.

16. An apparatus according to any of claims 12 to 15, wherein the treatment vessel is positioned upon a vertical support overlying a top opening of the cess-pit, the support extending downwardly through the top opening so that its lower extent is below the cess-pit discharge outlet, the centrifugal pump being mounted on the lower extent of the vertical support so as to be positionable below the surface of the sewage in the cess-pit.

17. An apparatus according to any of claims 12 to 16, wherein the centrifugal pump includes a hollow impeller blade having an internal passageway extending along its entire length, a hollow driveshaft being connected at its lower end to the impeller blade and having an internal passageway in communication with a central portion of the interior of the impeller blade, and the impeller blade having sharp trailing edge portions adjacent the ends of the hollow passageway.

18. An aerobic sewage treatment apparatus according to claim 12, substantially as hereinbefore described with reference to the accompanying drawings.

19. A method of treating a contaminated liquid, for example domestic sewage, which comprises withdrawing a portion of the contaminated liquid from a cess-pit and injecting it into a closed treatment vessel, causing the liquid to flow tangentially through the vessel under conditions of hydraulic turbulence, so that floc particles in the liquid are subjected to shear forces by moving across contacting and reducing members disposed in the vessel, and injecting an oxygen-containing gas into the vessel, whereby the portion of the contaminated liquid is aerobically treated by micro-liquefaction of the floc particles in the contaminated liquid.

20. A method according to claim 19, wherein a portion of the contaminated liquid is continuously withdrawn from the cess-pit and the micro-liquefied treated liquid is returned to the cess-pit above the level of the contaminated liquid contained therein.

21. A method according to claim 19 or 20, wherein floc particles contained in the contaminated liquid, as it is withdrawn from the cess-pit, are subjected to a first size reduction prior to being injected into the treatment vessel.

22. A method according to any of claims 19 to 21, wherein a portion of the micro-liquefied treated liquid is directed to a discharge outlet of the cess-pit.

23. A method according to claim 19, substantially as hereinbefore described with reference to the accompanying drawings.

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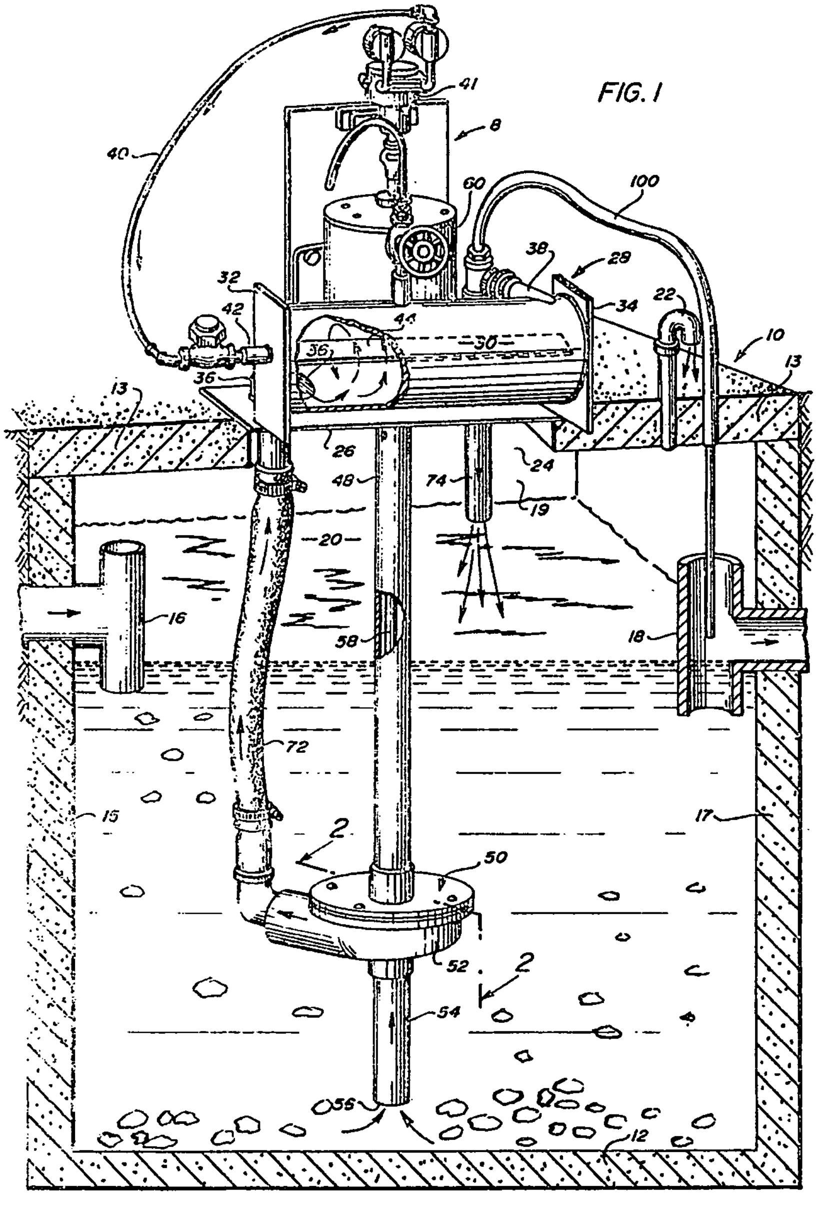

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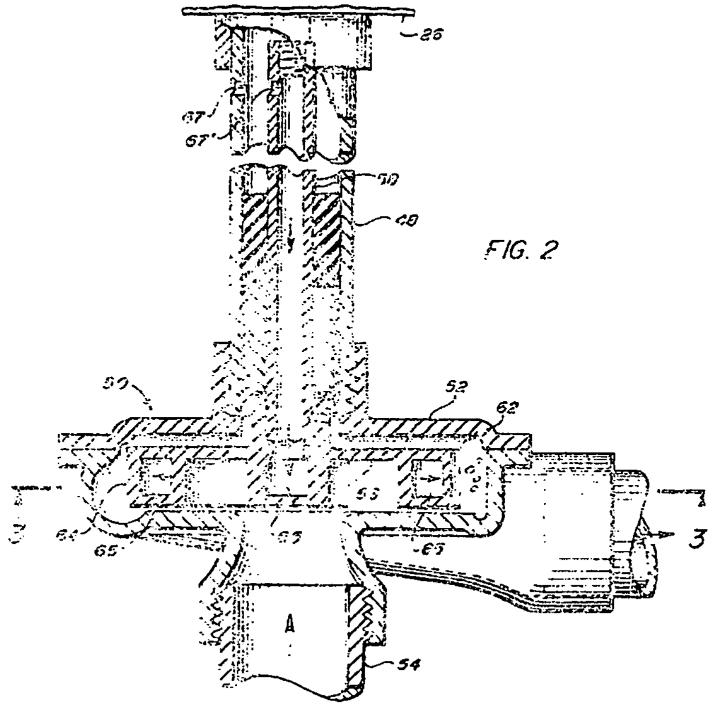

FIG. 2

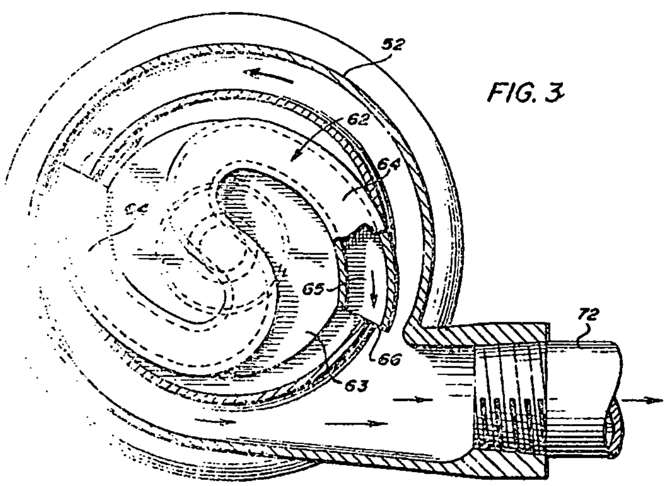

FIG. 3

1570202 COMPLETE SPECIFICATION

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Sheet 3

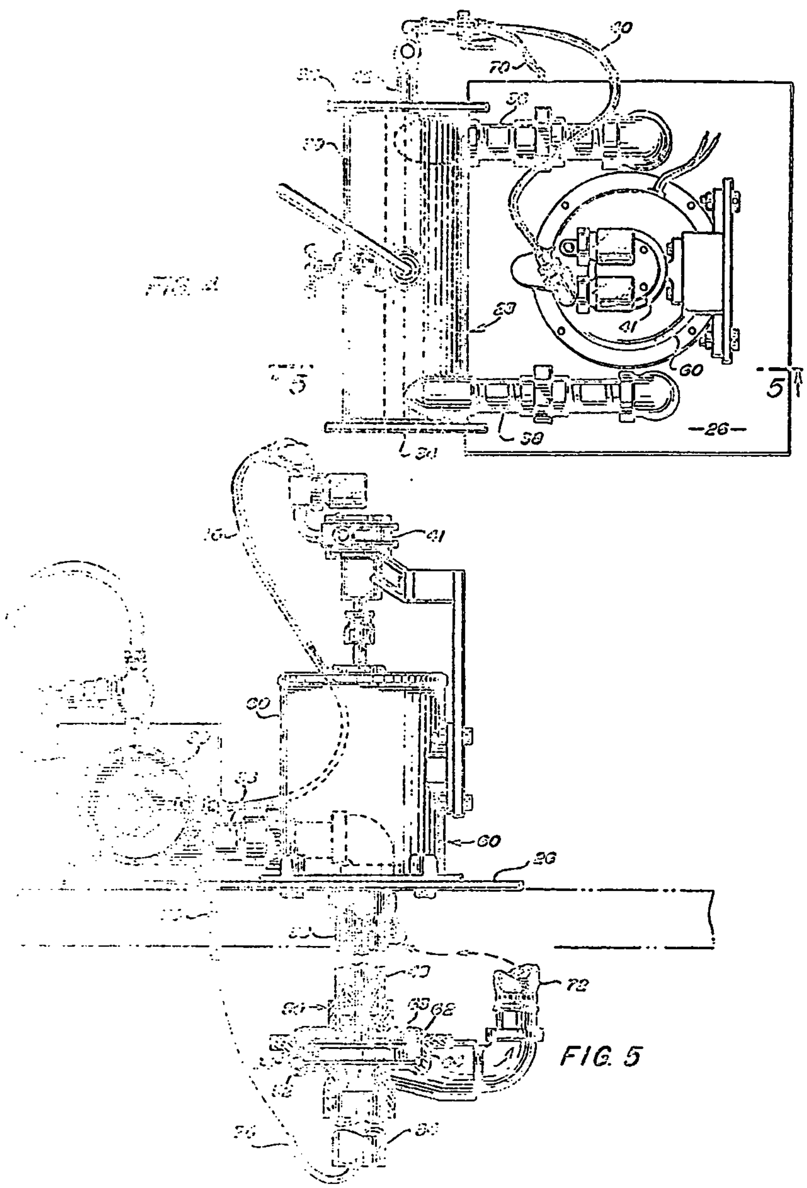

FIG. 5